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SCIENTIFIC COMPUTER DIVISION

Report No. RRC-38

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RIDE CHARACTERISTICS OF LIGHTWEIGHT TRACKED VEHICLES

by

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U. S. Army Tank-Automotive Command
Mobility Systems Laboratory
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ABSTRACT

The ride characteristics of a series of lightweight track vehicles were studied on the analog computer. The maximum tolerable speeds were obtained for five vehicles: The Weasel, Polecat, Thiokol Spryte, Westerasmåskiner Snow-Trac, and a tractor traveling over a hard meadow terrain.

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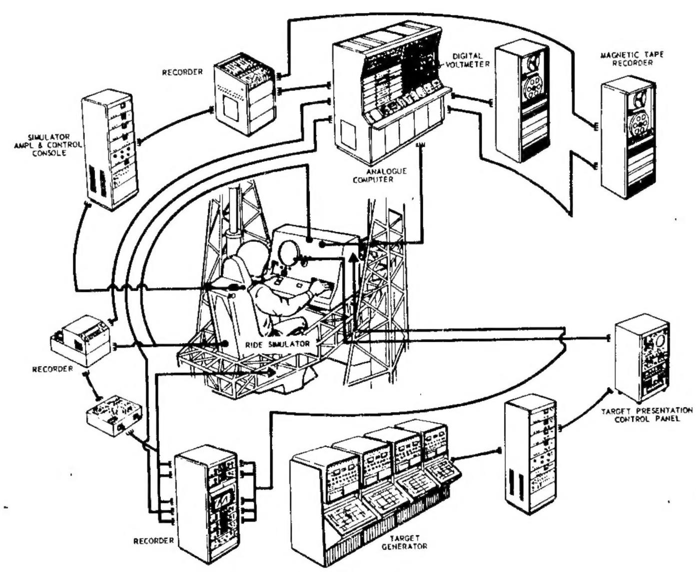
INTRODUCTION

The ride analysis for five existing lightweight tracked vehicles was conducted to illustrate and correlate the method of absorbed power for determining maximum tolerable speed over a hard meadow terrain.

The study was performed using analog computer simulation techniques to obtain the vehicle motions. The motions were then reproduced into the ride simulator and into the absorbed power circuitry to obtain the limiting maximum vehicle speed by both the ride simulator and the absorbed power techniques. The resultant data was then compared to maximum vehicle speeds measured over the actual test course.



Ride Simulator, Fig. 1

DISCUSSION

Analytical prediction of cross country speeds for concept vehicles has been performed by the Army Tank-Automotive Center for several years. The method employed describes the dynamic characteristics of a vehicle on an analog computer.[1,2] The calculated vehicle vibrations are then applied as the input function to a ride simulator for subjective evaluation by experienced vehicle test drivers.

Recently, a new purely analytical method was developed, "Absorbed Power".[3] Absorbed power is the rate at which energy is absorbed by a human body while being subjected to a vibration. Extensive testing has correlated absorbed power with subjective response as a measure of vibration severity from barely perceptive levels to maximum tolerable limits. When transfer function techniques are applied, absorbed power can be measured from only an acceleration without the use of a test subject.

The analog computer/ride simulator technique and absorbed power method has been correlated with field test data for a heavy tracked vehicle. However, the technique has not been compared with field tests of lightweight track vehicles of the Polecat, Weasel, Snow-Trac, Spryte and tractor class. For additional correlation, a simulation study was performed of these vehicles traversing a known terrain and comparing the results to field test data. Because of the magnitude of instrumentation required for measuring actual vehicle motion, the maximum tolerable speed of the drivers' position was the basis for the correlation study. Each of the five vehicles were driven over the course at the maximum speed attainable by the driver without severe discomfort or loss of control. This velocity was then considered the maximum tolerable limit.

The analytical experiment was conducted by obtaining the required vehicle data and a profile of the terrain used. The data is shown in Appendices A and B, respectively.[4] Only pitch and vertical motions were studied on the computer for the simulated speeds in Table I.

TABLE I

Vehicle	Vehicle Speed (MPH)
Snow-Trac	5, 7, 10, 15, 20, 25, 30
Spryte	5, 7, 10, 15, 20, 25, 30
Weasel	5, 7, 10, 12.5, 15, 20, 25
Polecat	5, 7, 10, 15, 20, 25
Tractor	1, 2, 4, 5, 7, 10

The simulated ride motions at each of these speeds were recorded on magnetic tape for subsequent use as input to the "absorbed power" circuitry and the ride simulator.

The ride simulator is capable of four degrees of motion, pitch, roll, bounce and yaw. It is hydraulically driven and electronically controlled. Each of the motions may be used individually or simultaneously. Random motion inputs to the simulator may be obtained directly from the analog computer or by reproducing information previously recorded on magnetic tape. Details of the simulators capabilities are given below:

MOTION	MAXIMUM TOTAL TRAVEL	MAXIMUM FREQUENCY, H_Z
Bounce	2 feet	60
Roll	30 degrees	60
Pitch	30 degrees	60
Yaw	20 degrees	3

It has been established that a reasonable tolerable limit of human vibration for random, sinusoidal or other inputs to the absorbed power circuitry is six watts. The measurement may be made by measuring the absorbed power of a test subject or by calculating the absorbed power analytically through the use of a transfer function. The values of vehicle speed based on absorbed power derived from the method are compared in the summary with experimental measured values.

SUMMARY

The absorbed power for the vehicles studied was plotted in Figure 2. These results were then graphically interpolated for the maximum tolerable speed at the six watt reference level. A comparison of the field trial data and analytical method is shown in Table II.

TABLE II

Vehicle	Analytical Prediction	Field Trial
Snow-Trac	16.3	16.5 MPH
Spryte	15.2	15.7 MPH
Weasel	14.0	15.3 MPH
Polecat	11.0	13.6 MPH
Tractor	3.5	6.0 MPH

The correlation, as shown in the above table, was considered satisfactory. The large deviation in the tractor results were due to the limited definitive data on the rigid suspension characteristics. The details of the Polecat articulation joint were also not exact and, hence, greater simulation error was expected.

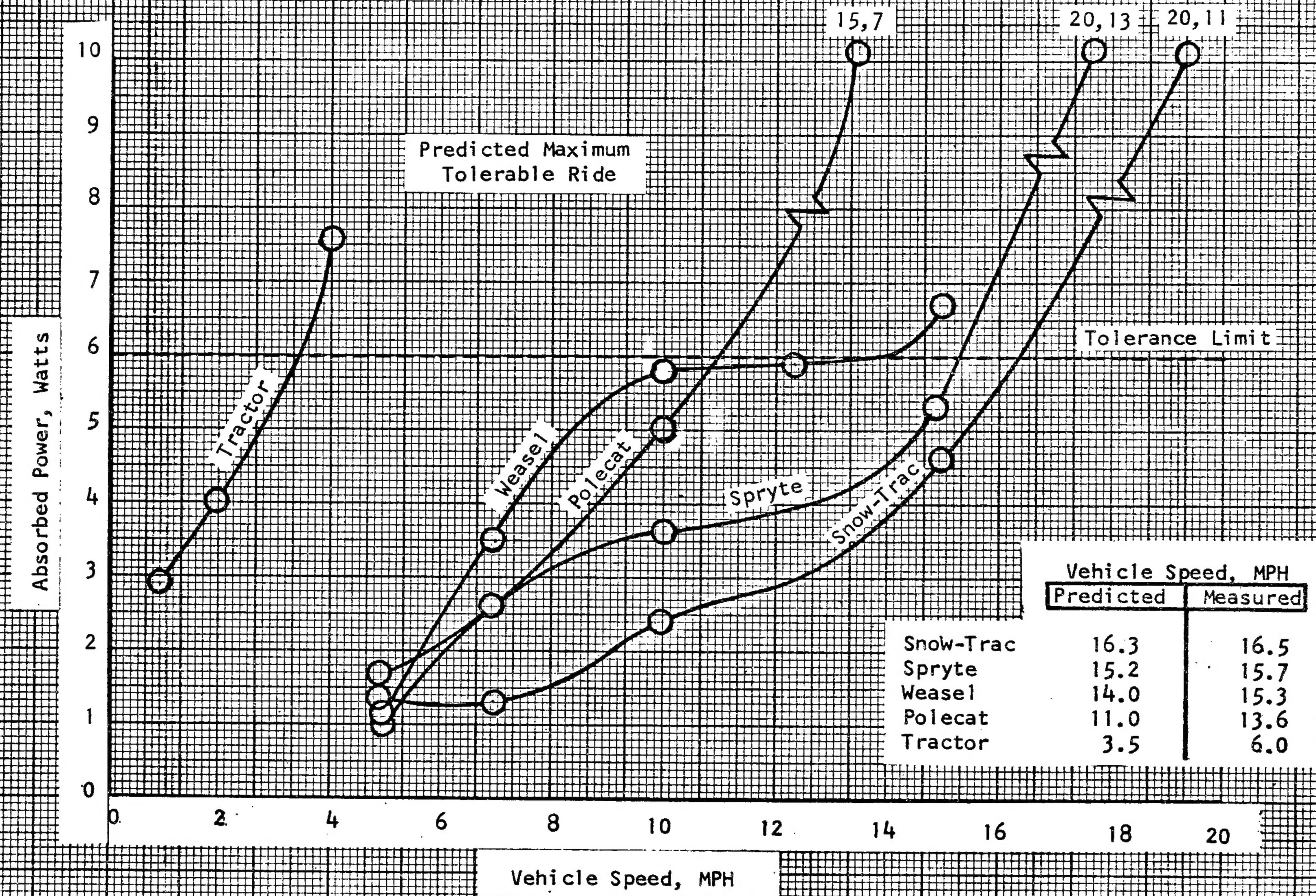


FIGURE 2. Absorbed Power versus Vehicle Speed.

Reference:

1. ATAC Report RR-38, "Suspension Analysis", S. F. Heal.

2. ATAC Report RR-44, "Generation of Road Profile for Vehicle Ride Simulations", M. Archambault and S. F. Heal.

3. ATAC Report RRC-28, "Theory of Human Vibration Response".

4. The vehicle data, terrain profile, and experimental speed test data were obtained from the Michigan Technological University under Contract No. DA-20-113-AMC-08571 (T).

APPENDIX A
Vehicle Data

SNOW-TRAC

SNOW-TRAC

Total Weight	3140 Lbs.
Sprung Weight	2877 Lbs.
Unsprung Weight	263 Lbs.
Sprung Pitch Moment of Inertia	1600 $Slug\text{-}Ft^2$
Distance from Ground to Center of Gravity	25 Inches
Shock Absorbers Assume Vertical Damping Ratio of .2	Data not available

Roadwheel Damping: Assume equal to .2 of critical

Idler Damping: Assume equal to .2 of critical

Vehicle Dimensions: See Figure 4.

Spring Rates: See Figures 5 and 6.

Bogie Moment of Inertias: Estimated.

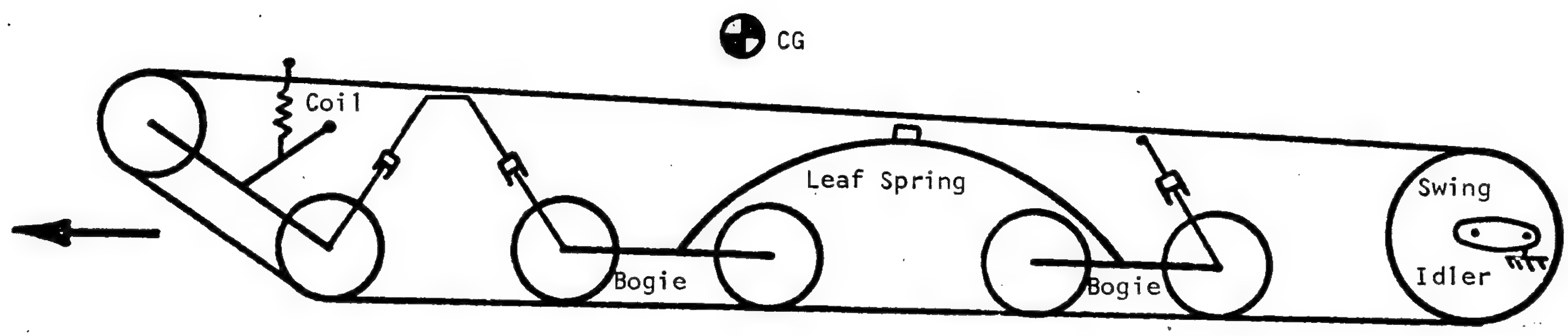


Fig. 3

SNOW-TRAC SUSPENSION CONFIGURATION

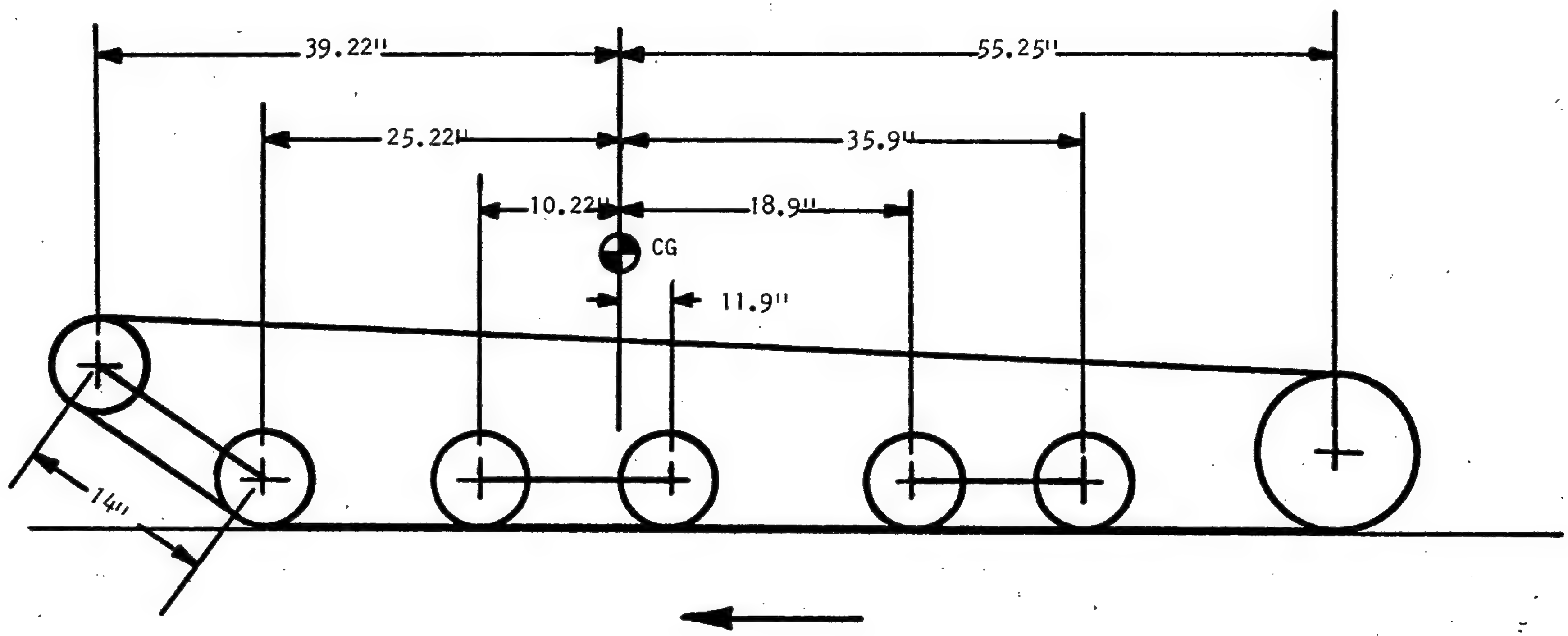


Fig. 4

SNOW-TRAC ROADWHEEL TO CG DIMENSIONS

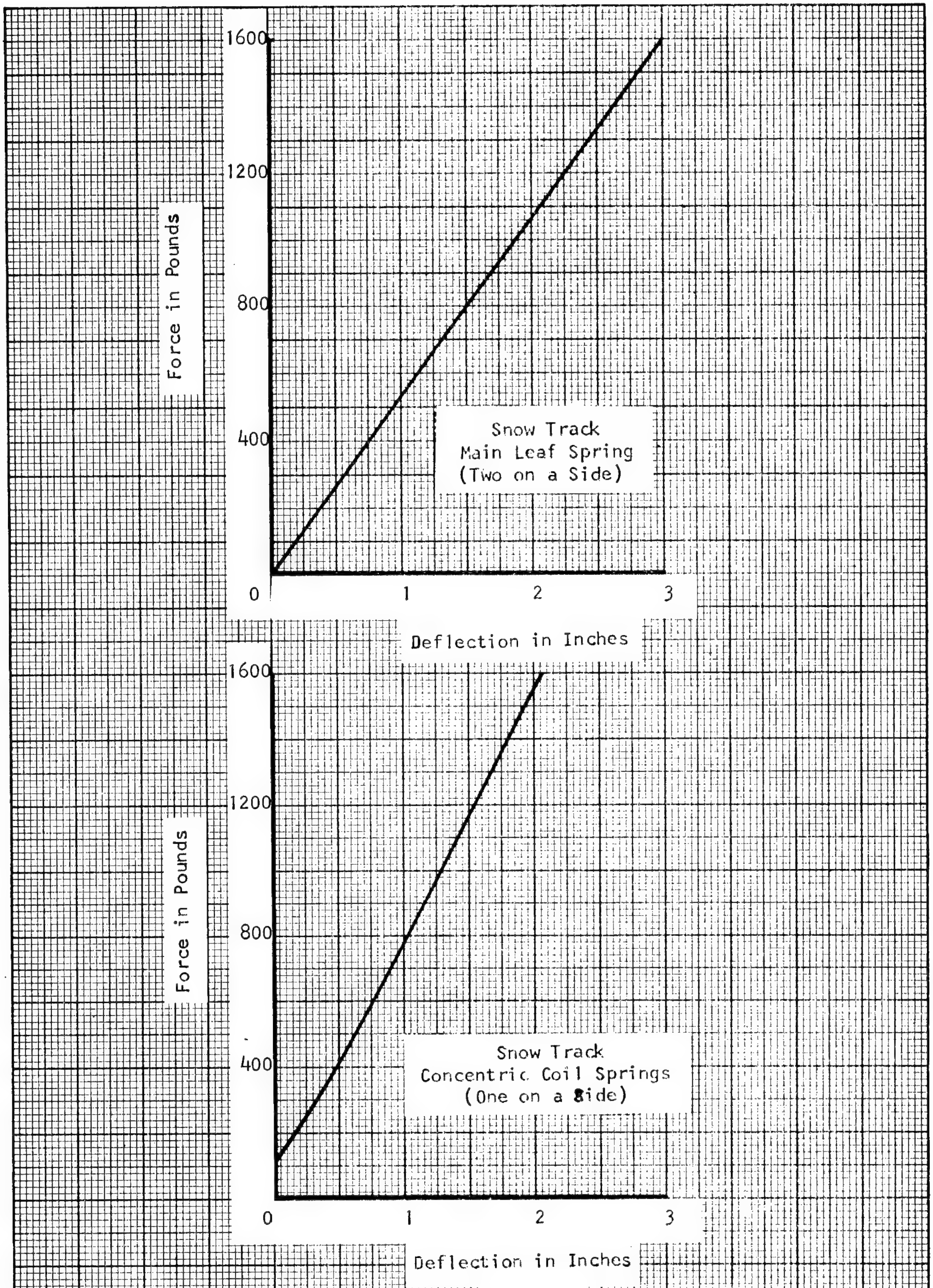

1600
1200
800
400
0
1
2
3
Force in Pounds
Deflection in Inches
Snow Track
Main Leaf Spring
(Two on a Side)
Snow Track
Concentric Coil Springs
(One on a Side)

FIGURE 5.

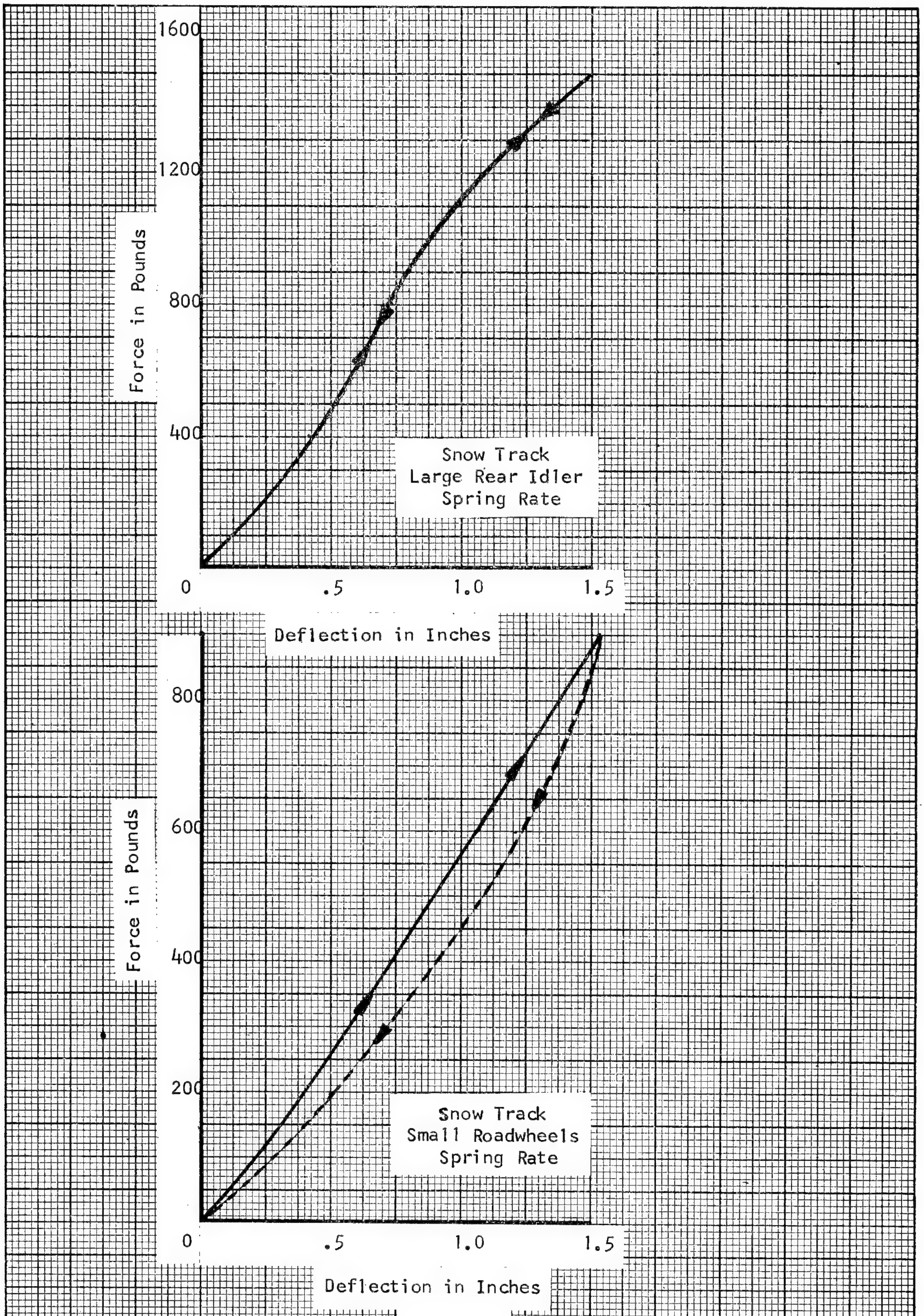

1600
1200
800
400
Force in Pounds
Snow Track
Large Rear Idler
Spring Rate
0
.5
1.0
1.5
Deflection in Inches
800
600
400
200
Force in Pounds
Snow Track
Small Roadwheels
Spring Rate
0
.5
1.0
1.5
Deflection in Inches

FIGURE 6.

SPRYTE

SPRYTE

Total Weight	3425 Lbs.
Sprung Weight	3016 Lbs.
Unsprung Weight	409 Lbs.
Sprung Pitch Moment of Inertia	1993 Slug-Ft^2
Distance from Ground to Center of Gravity	28 Inches
Shock Absorbers Assume Vertical Damping Ratio of .2	None

Roadwheel Damping: Assume equal to .1 of critical.

Vehicle Dimensions - see Figure 7.

Spring Rates - see Figures 8 and 9.

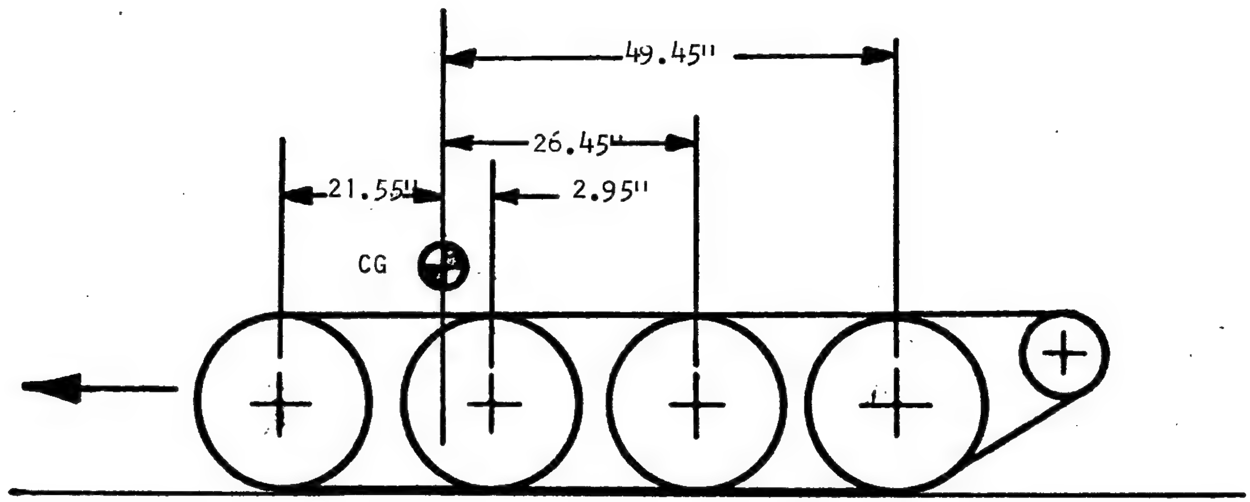


Fig. 7

SPRYTE ROADWHEEL TO CG DIMENSIONS

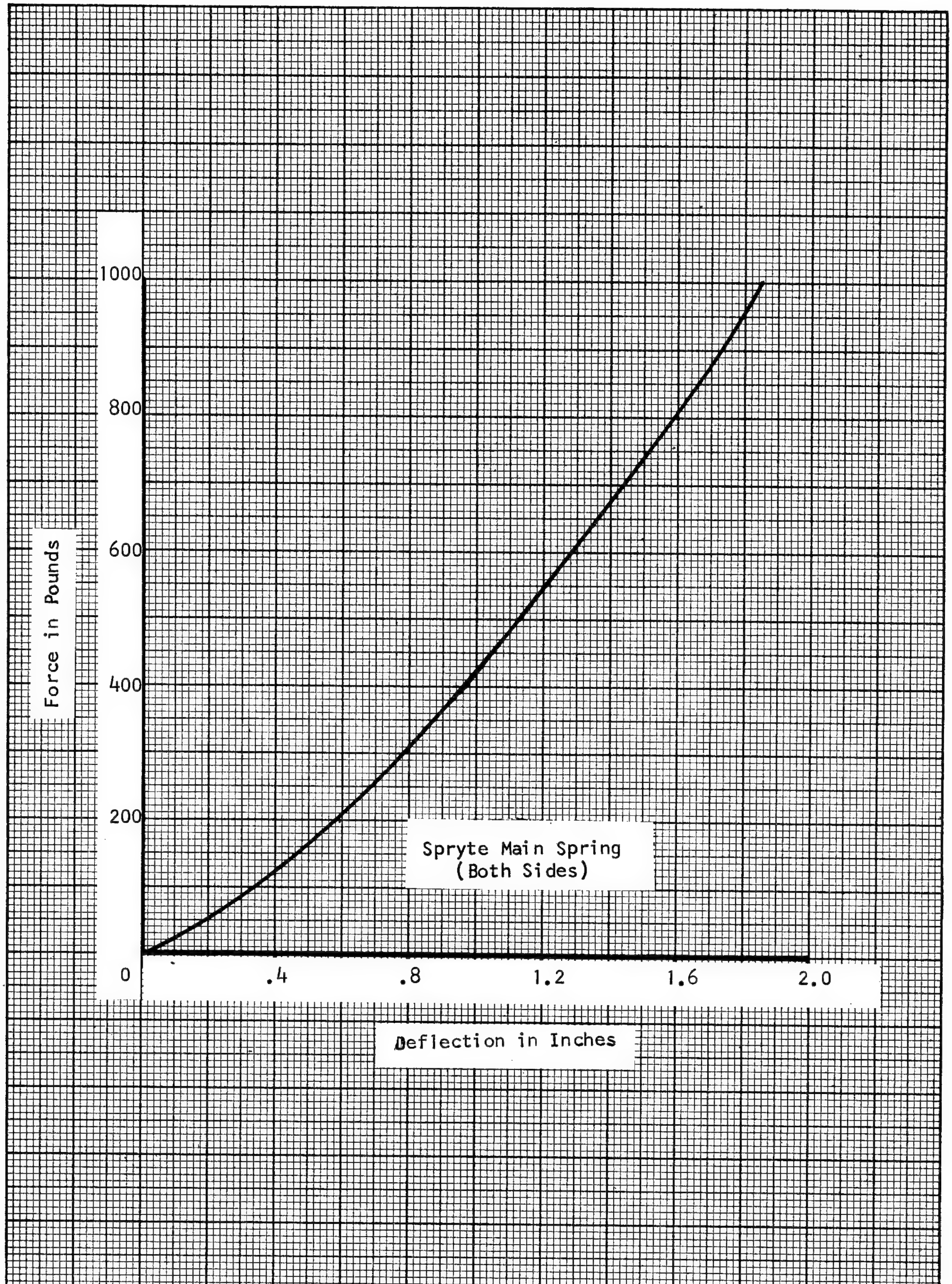

1000
800
600
400
200
0
Force in Pounds
.4
.8
1.2
1.6
2.0
Deflection in Inches
Spryte Main Spring
(Both Sides)

FIGURE 8

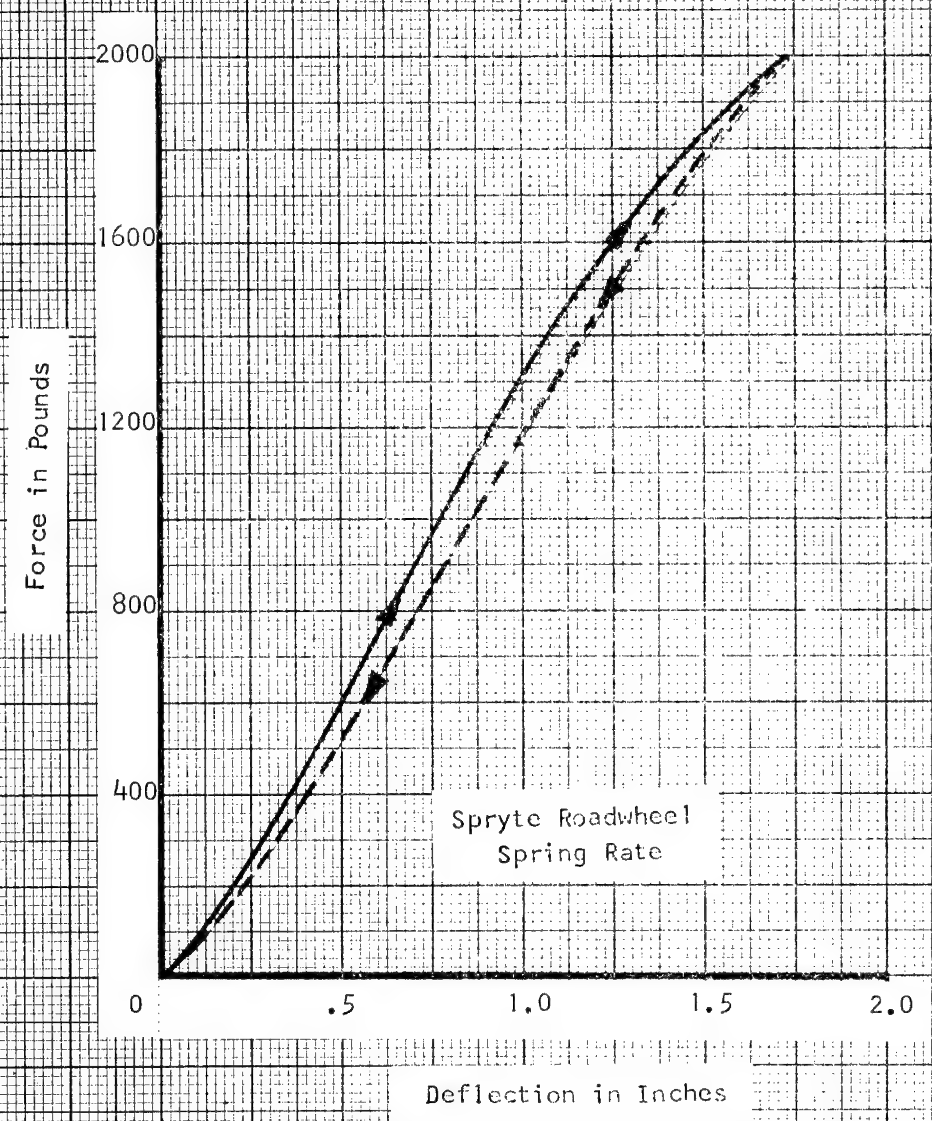

2000
1600
1200
800
400
0
.5
1.0
1.5
2.0
Force in Pounds
Deflection in Inches
Spryte Roadwheel
Spring Rate

FIGURE 9

WEASEL

WEASEL

Total Weight	4740 Lbs.
Sprung Weight	4168 Lbs.
Unsprung Weight	572 Lbs.
Sprung Pitch Moment of Inertia	3200 Slug-Ft^2
Distance from Ground to Center of Gravity	25.6 Inches
Shock Absorbers Assume vertical damping ratio of .3	Data not available

Roadwheel Damping: Assume equal to .1 of critical.

Vehicle dimensions: See Figures 10 and 11.

Spring Rates: See Figures 12 and 13.

Bogie Moment of Inertias: Estimated.

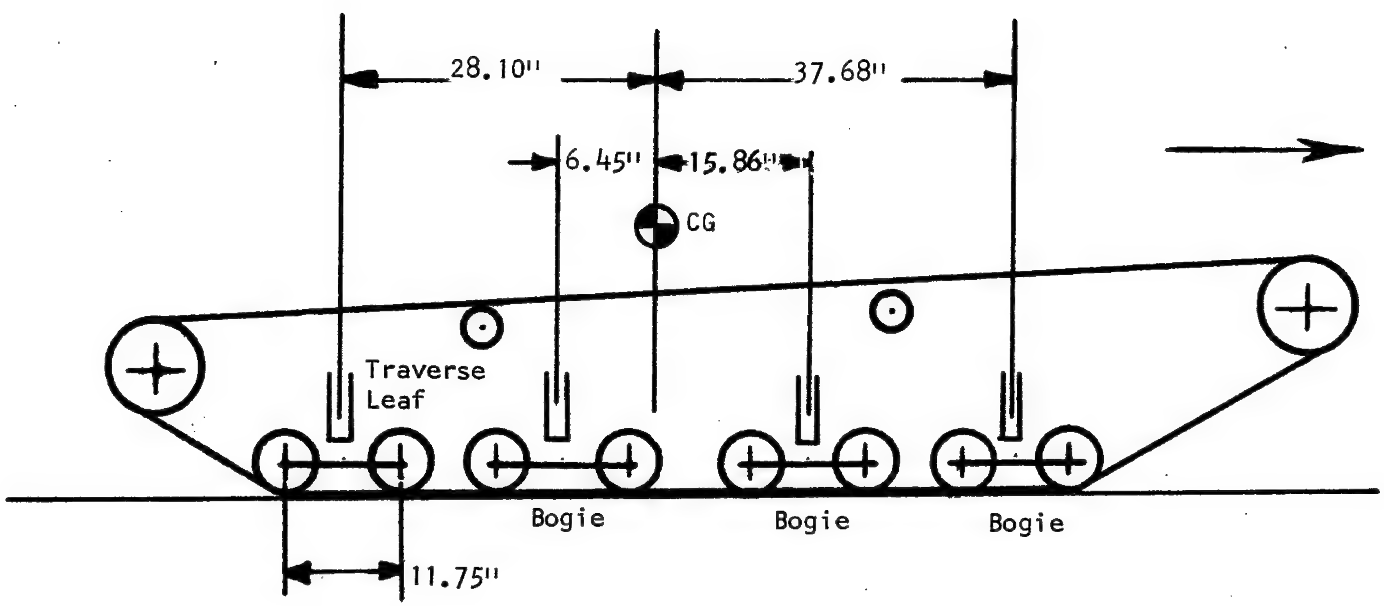


Fig. 10

WEASEL ROADWHEEL TO CG DIMENSIONS

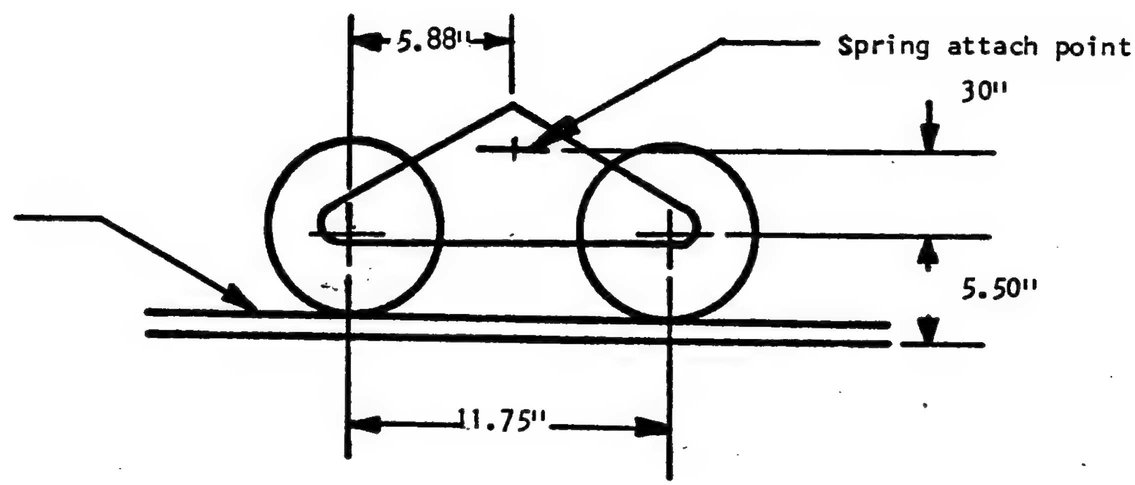
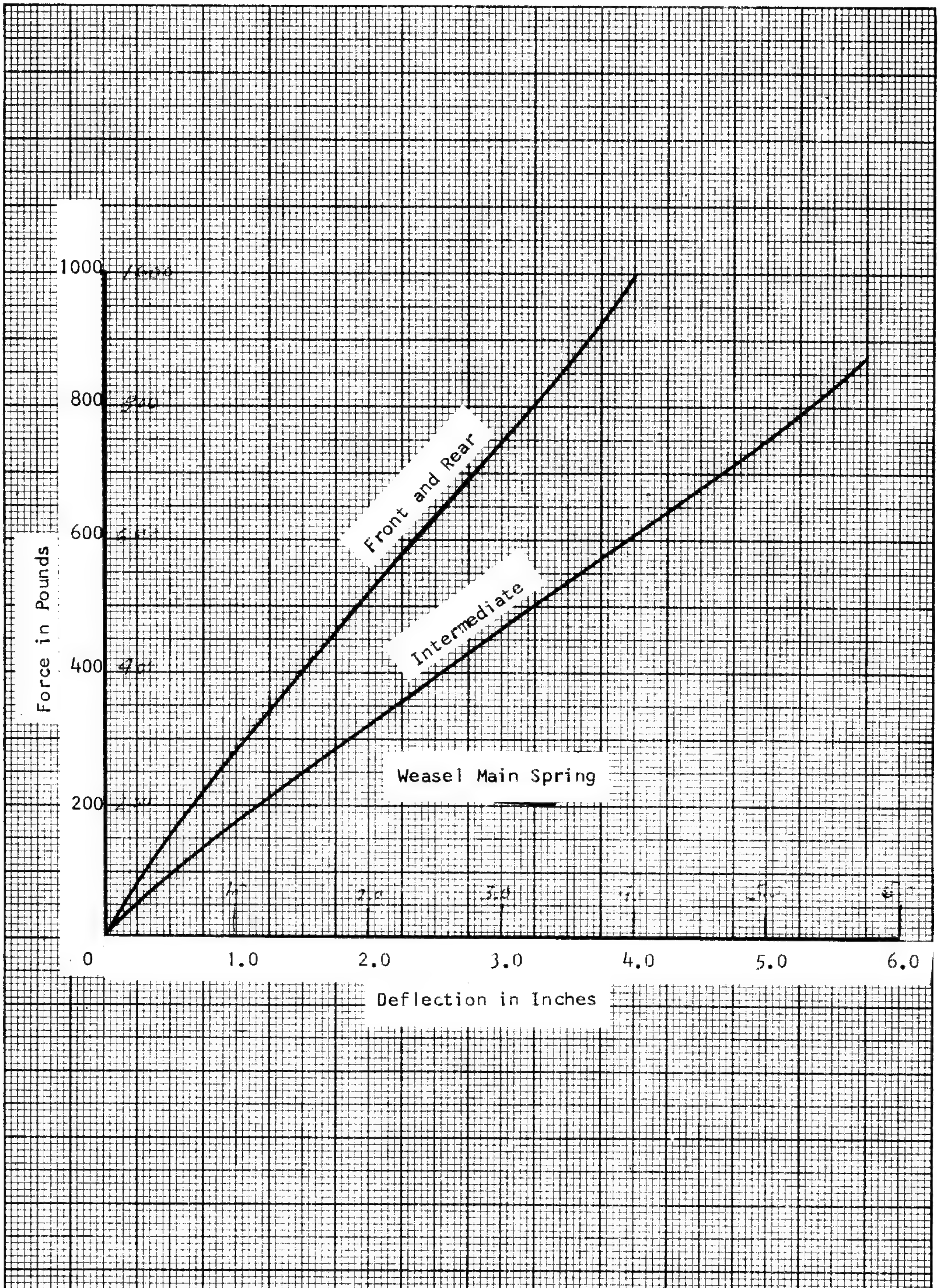


Fig. 11

BOGIE DETAILS



Force in Pounds
1000
800
600
400
200
0
1.0
2.0
3.0
4.0
5.0
6.0
Deflection in Inches
Front and Rear
Intermediate
Weasel Main Spring

FIGURE 12

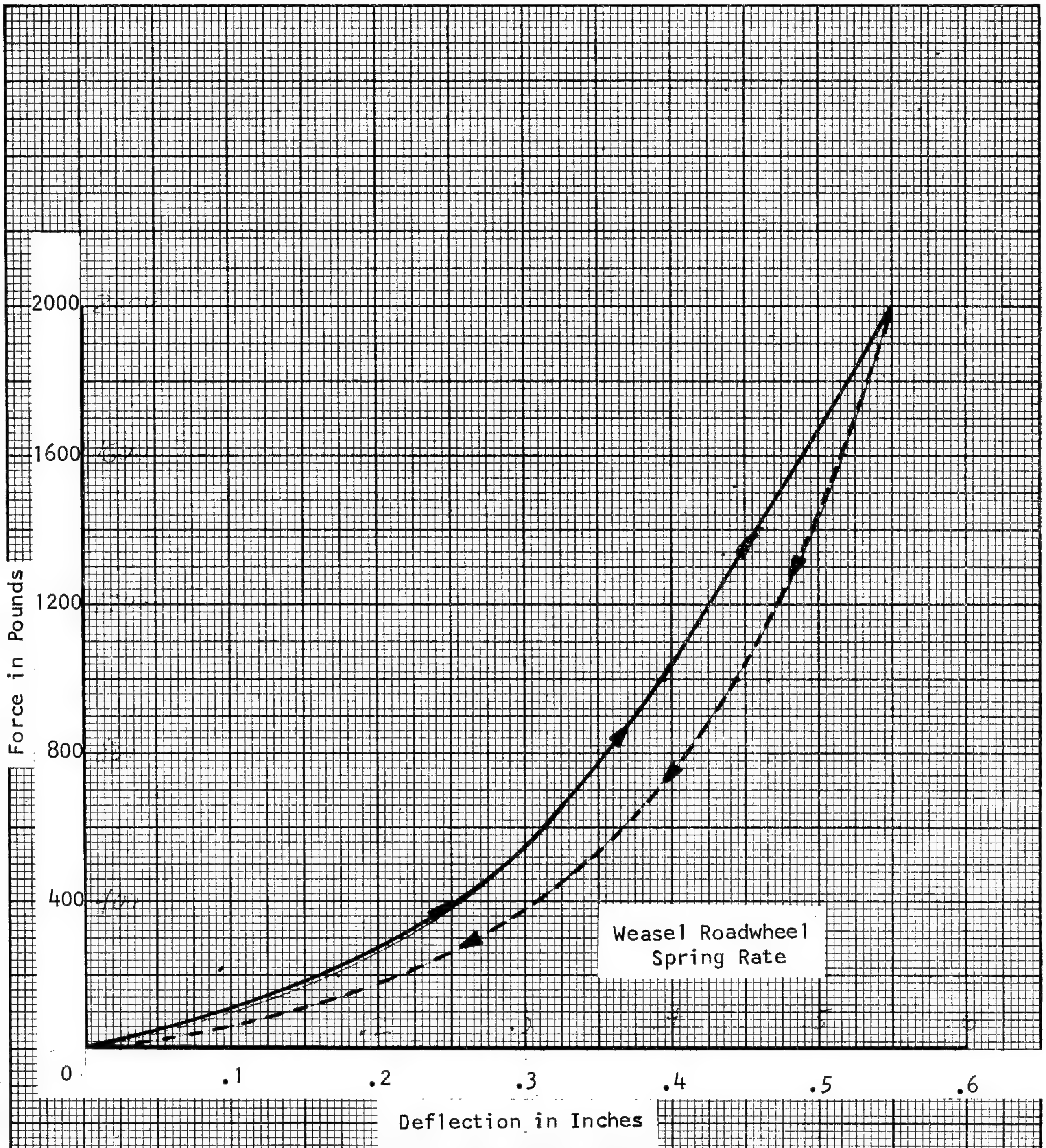

Force in Pounds
2000
1600
1200
800
400
0
.1
.2
.3
.4
.5
.6
Deflection in Inches
Weasel Roadwheel
Spring Rate

FIGURE 13

POLECAT

POLECAT

Total Weight	Front Unit	5982 Lbs.
	Rear Unit	5407 Lbs.
Sprung Weight	Front Unit	5400 Lbs.
	Rear Unit	4925 Lbs.
Unsprung Weight	Front Unit	582 Lbs.
	Rear Unit	482 Lbs.
Sprung Pitch Moment of Inertia	Front Unit	4300 Slug-Ft^2
	Rear Unit	3865 Slug-Ft^2
Distance from Ground to Center of Gravity		
	Front Unit	24 Inches
	Rear Unit	28 Inches
Shock Absorbers		Data Not Available

Assume Vertical Damping Raio of .3, both Units

Roadwheel Damping: Assume Damping Ratio of .1, both units

Vehicle Dimensions: See Figures 14, 15, and 16.

Spring Rates: See Figures 17, 18, 19, and 20.

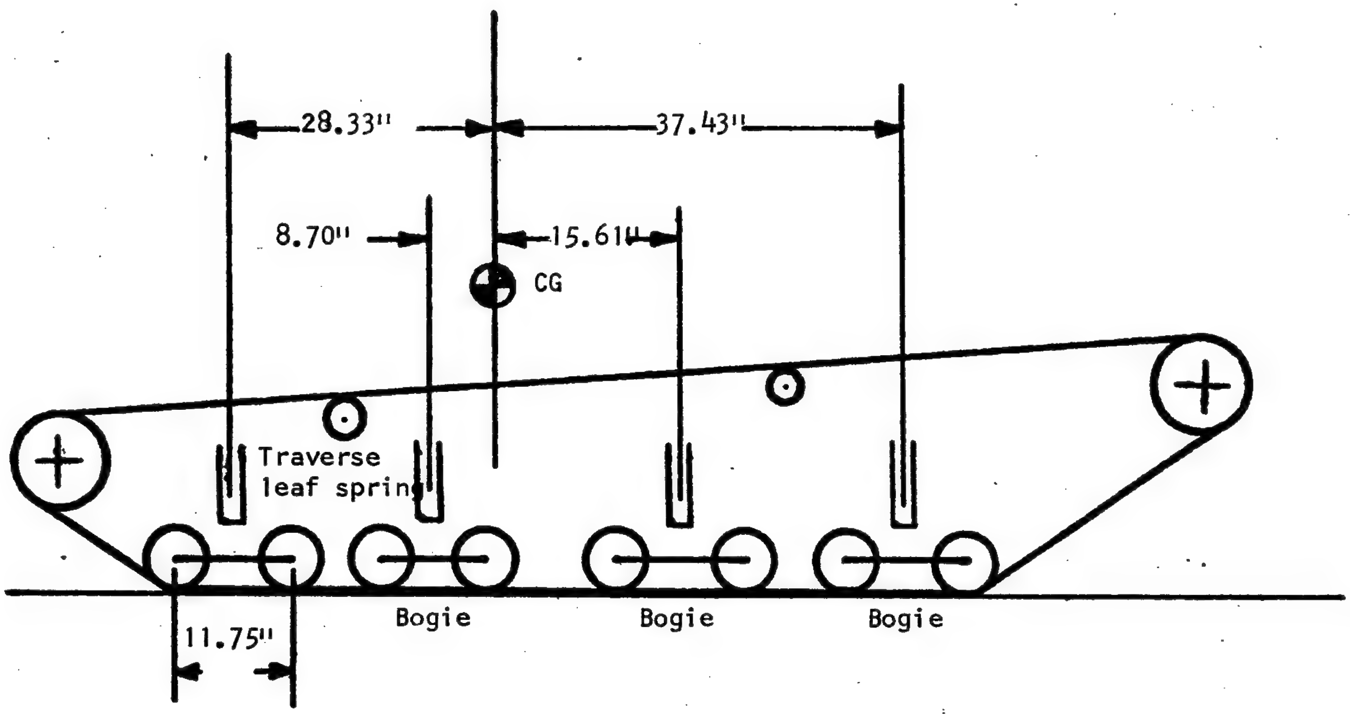


Fig. 14

POLECAT POWER UNIT ROADWHEEL TO CG DIMENSIONS

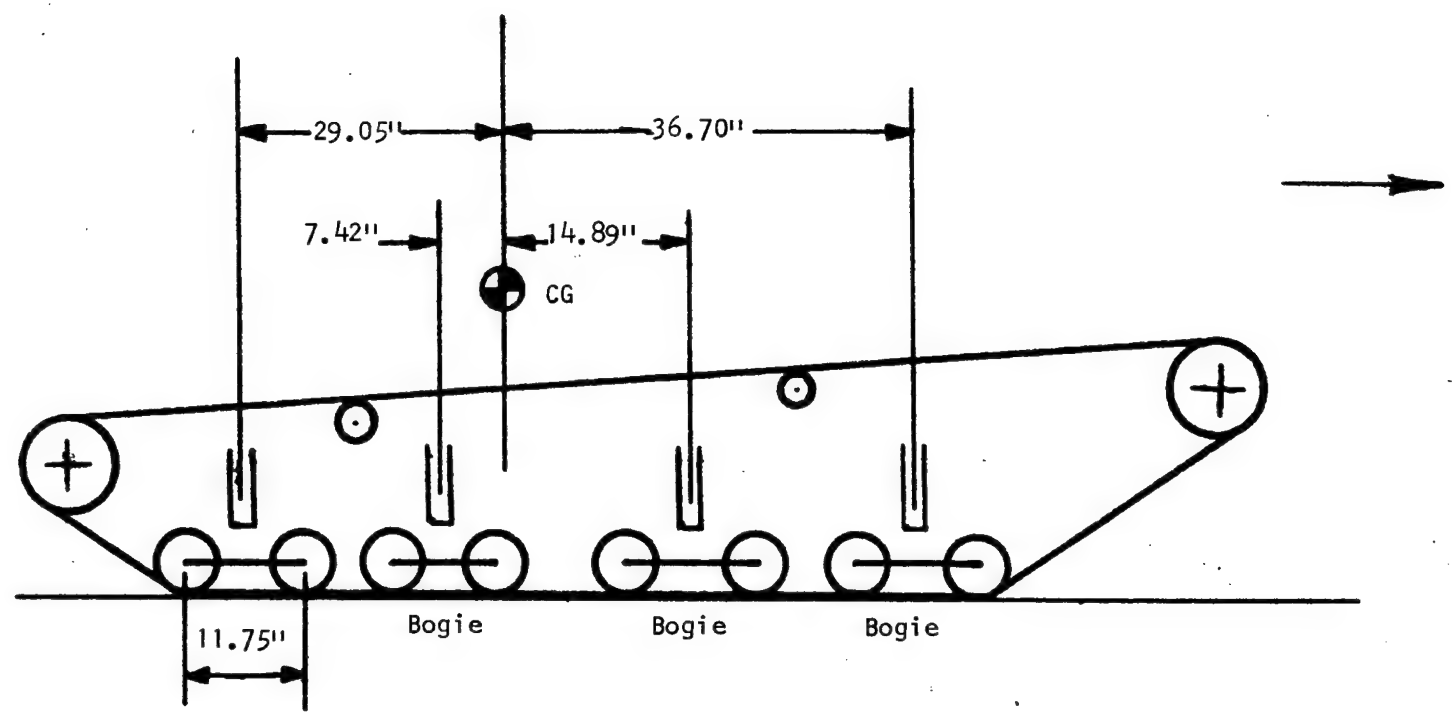


Fig. 15

POLECAT TRAILER UNIT ROADWHEEL TO CG DIMENSIONS

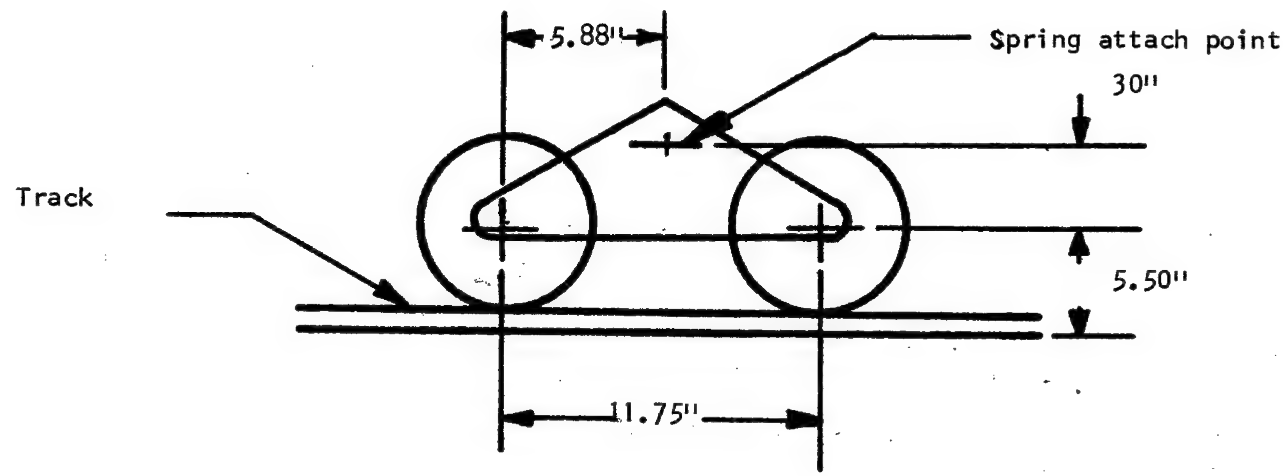


Fig. 16

BOGIE DETAILS

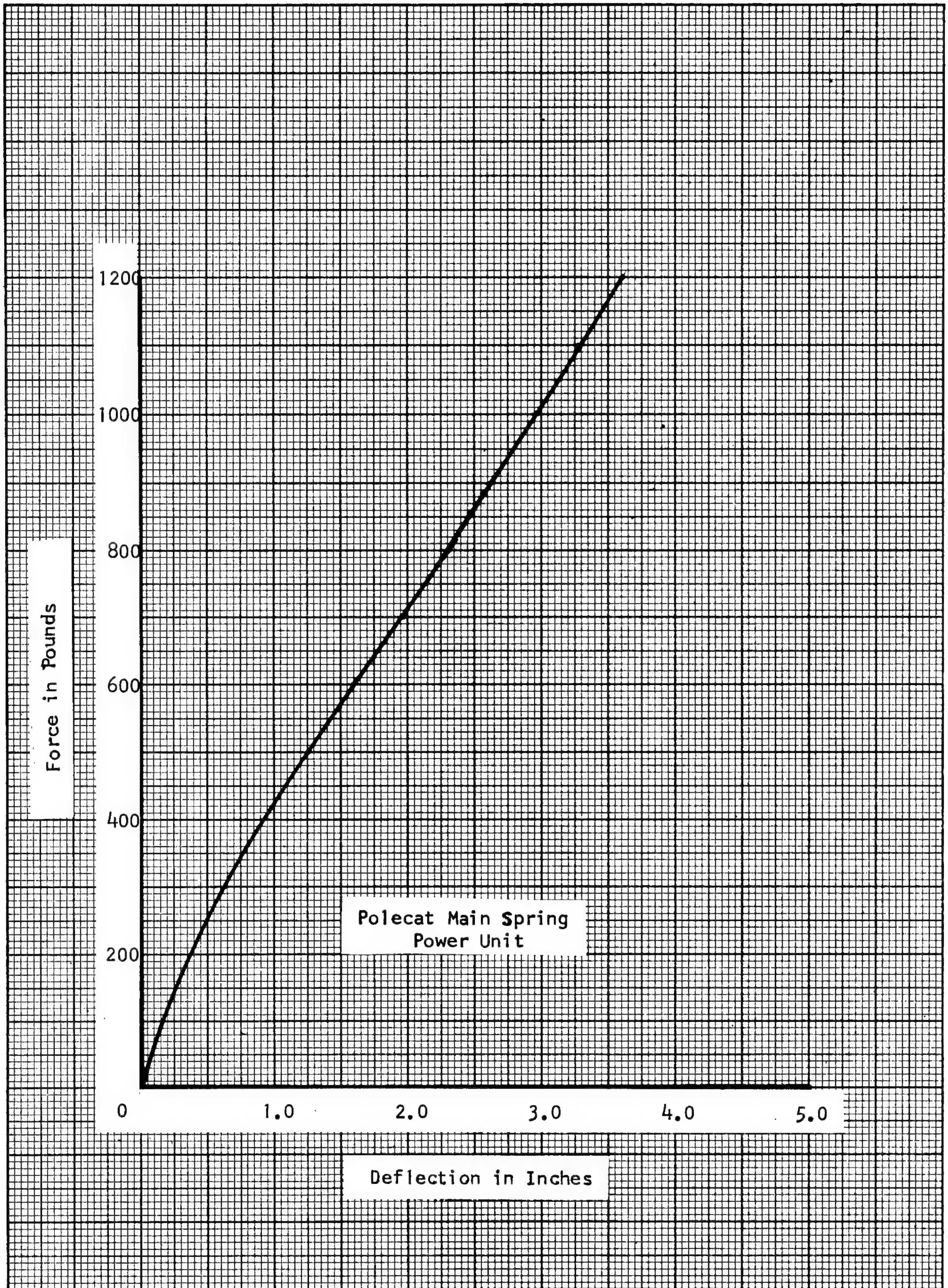

1200
1000
800
600
400
200
0
1.0
2.0
3.0
4.0
5.0
Force in Pounds
Deflection in Inches
Polecat Main Spring
Power Unit

FIGURE 17

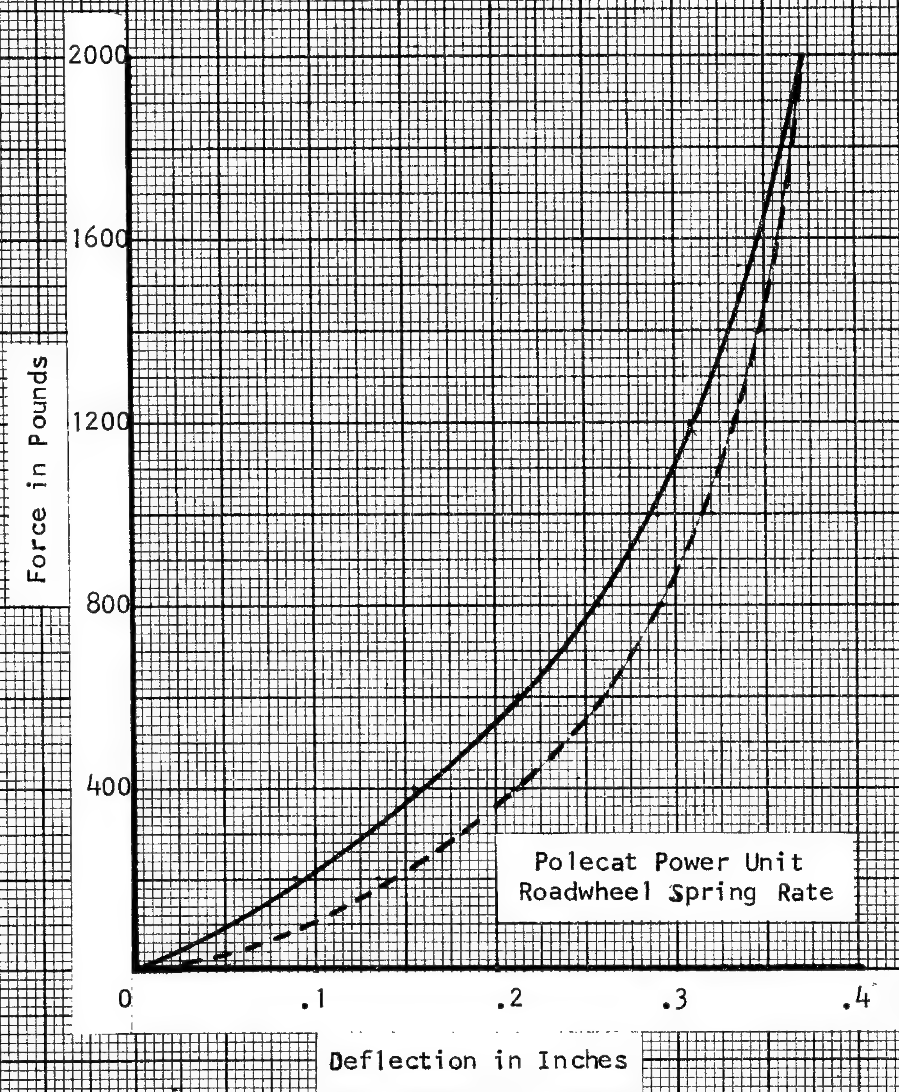
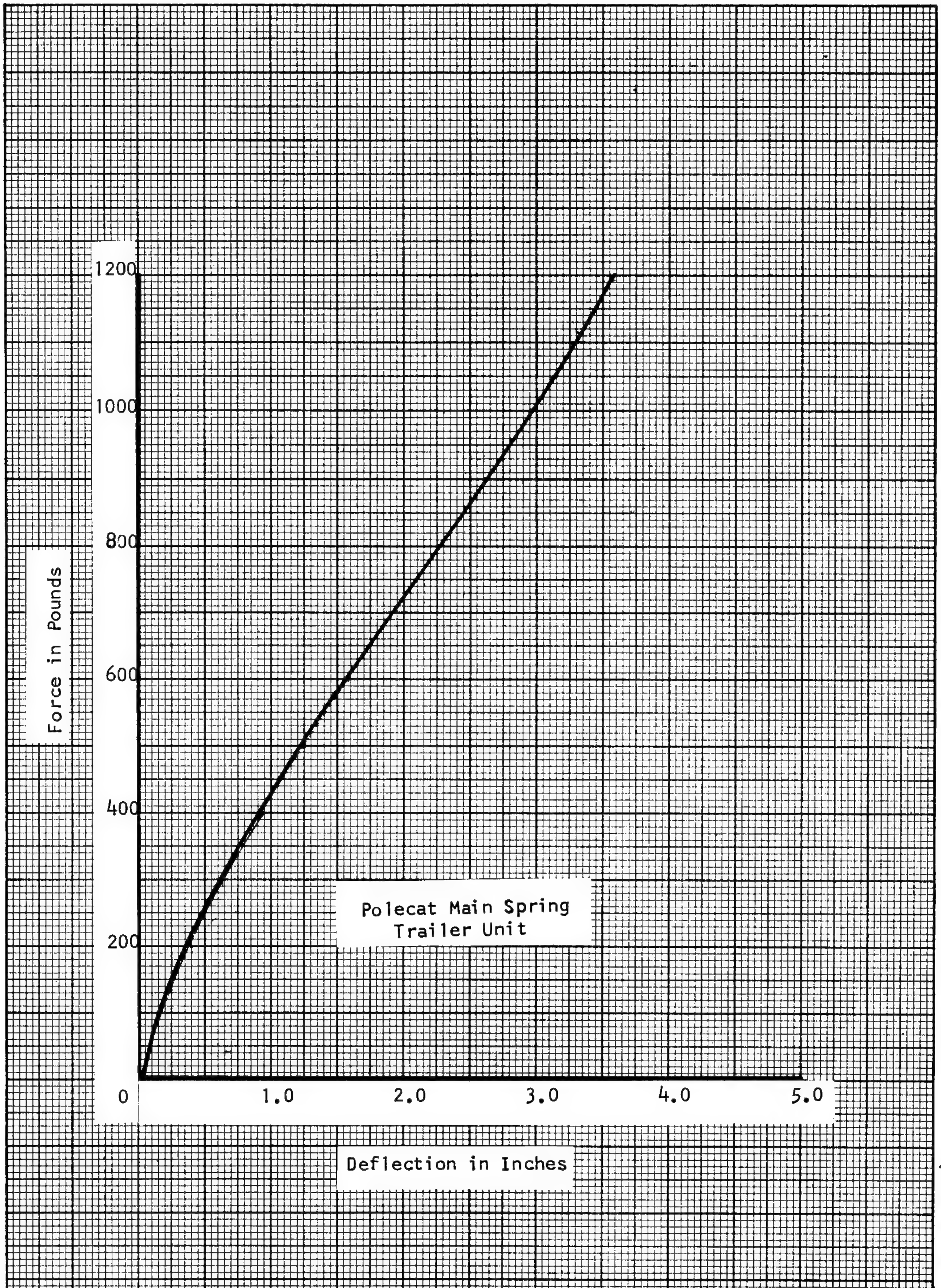

2000
1600
1200
800
400
Force in Pounds
0
.1
.2
.3
.4
Deflection in Inches
Polecat Power Unit
Roadwheel Spring Rate

FIGURE 18



Force in Pounds
1200
1000
800
600
400
200
0
1.0
2.0
3.0
4.0
5.0
Polecat Main Spring
Trailer Unit
Deflection in Inches

FIGURE 19

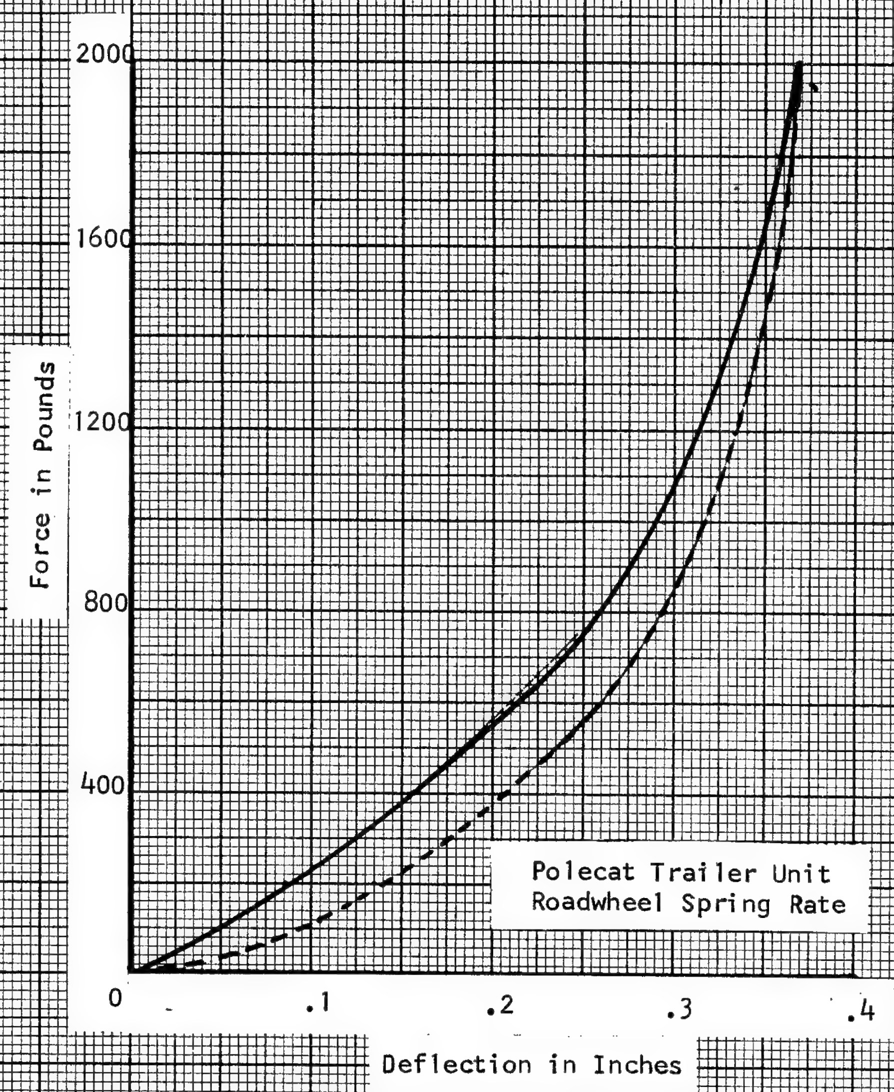

Force in Pounds
2000
1600
1200
800
400
0
.1
.2
.3
.4
Deflection in Inches
Polecat Trailer Unit
Roadwheel Spring Rate

FIGURE 20

TRACTOR

TRACTOR

Total Weight	12,764 Lbs.
Pitch Moment of Inertia	11,500 Slug-Ft^2
Distance from Ground to Center of Gravity	22 Inches

Spring Rates per Wheel, estimated as 525,937 Lbs/Ft.

Vehicle Dimensions, see Figure 21.

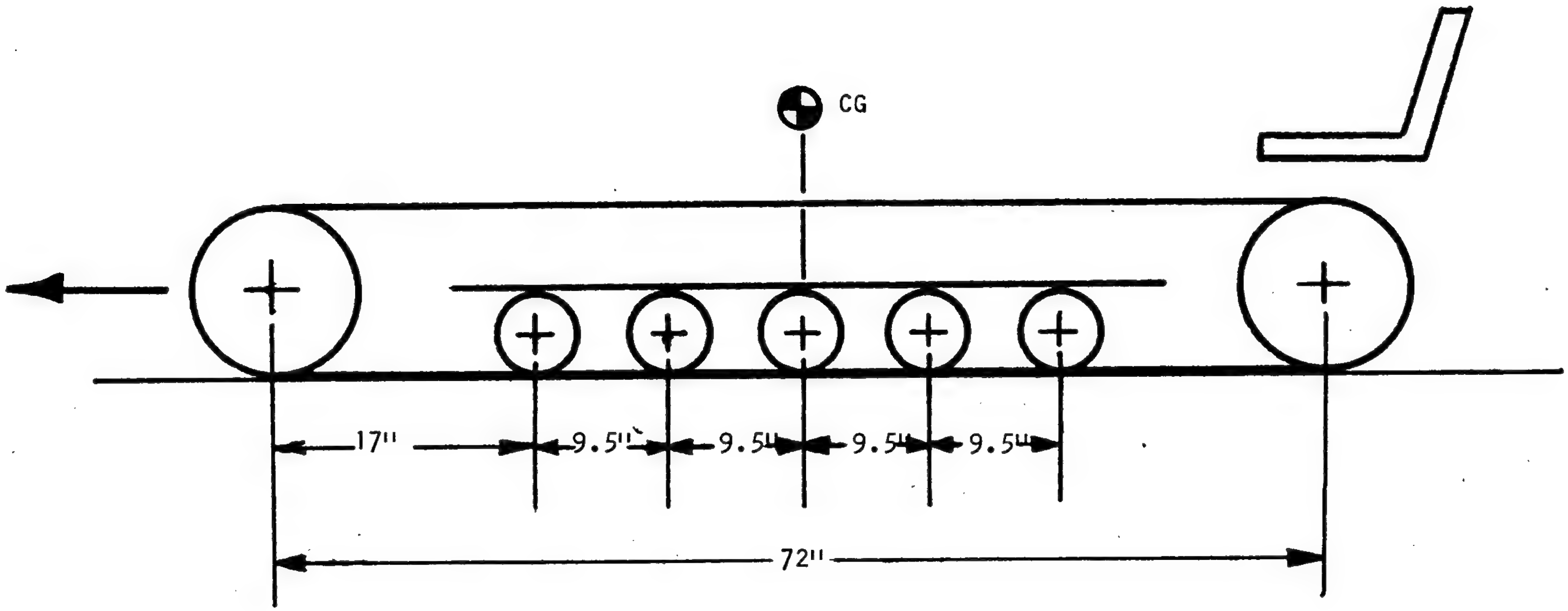


Fig. 21

TRACTOR ROADWHEEL TO CG DIMENSIONS

APPENDIX B

Terrain Profile Data

NUMERICAL PROFILE OF 600 FOOT HARD MEADOW

(Course Number I, All elevations taken above lowest point from East to West

Distance	North Track Elevation	South Track Elevation	Distance	North Track Elevation	South Track Elevation
0	5.46	5.25	31	5.34	5.17
1	5.37	5.31	32	5.16	5.17
2	5.30	5.39	33	5.11	5.11
3	5.37	5.44	34	5.06	5.15
4	5.37	5.41	35	5.12	5.23
5	5.37	5.37	36	5.30	5.34
6	5.38	5.33	37	5.42	5.44
7	5.37	5.35	38	5.42	5.51
8	5.39	5.40	39	5.51	5.45
9	5.37	5.38	40	5.55	5.42
10	5.47	5.39	41	5.55	5.38
11	5.48	5.44	42	5.46	5.33
12	5.48	5.50	43	5.23	5.29
13	5.58	5.51	44	5.06	5.26
14	5.58	5.48	45	4.92	5.20
15	5.57	5.34	46	5.03	5.16
16	5.66	5.32	47	5.16	5.01
17	5.69	5.35	48	5.15	4.85
18	5.68	5.36	49	5.15	4.76
19	5.59	5.43	50	5.11	4.73
20	5.44	5.43	51	4.94	4.78
21	5.37	5.37	52	4.90	4.94
22	5.24	5.27	53	4.92	5.04
23	5.26	5.16	54	5.08	5.22
24	5.36	5.25	55	5.14	5.29
25	5.34	5.27	56	5.17	5.34
26	5.31	5.28	57	5.21	5.32
27	5.25	5.33	58	5.26	5.30
28	5.29	5.37	59	5.27	5.28
29	5.29	5.29	60	5.28	5.26
30	5.37	5.21	61	5.28	5.24

Distance	North Track Elevation	South Track Elevation	Distance	North Track Elevation	South Track Elevation
62	5.27	5.14	97	4.95	5.09
63	5.20	5.05	98	4.91	5.06
64	5.27	5.02	99	4.89	4.99
65	5.27	4.95	100	4.85	4.97
66	5.16	4.93	101	4.86	4.94
67	5.13	4.98	102	4.87	4.92
68	5.12	4.98	103	4.90	4.93
69	5.11	4.98	104	4.90	4.95
70	5.11	4.95	105	4.95	4.97
71	5.10	4.91	106	5.01	4.99
72	5.07	4.96	107	4.99	4.98
73	4.99	5.01	108	4.98	4.97
74	4.94	5.06	109	5.00	4.85
75	4.90	5.04	110	4.94	4.81
76	4.87	5.04	111	4.83	4.76
77	4.85	4.97	112	4.79	4.77
78	4.83	4.96	113	4.75	4.77
79	4.81	4.89	114	4.83	4.77
80	4.80	4.87	115	4.82	4.77
81	4.76	4.77	116	4.81	4.77
82	4.79	4.78	117	4.82	4.80
83	4.83	4.80	118	4.82	4.82
84	4.86	4.79	119	4.84	4.85
85	4.86	4.82	120	4.85	4.89
86	4.86	4.89	121	4.91	4.93
87	4.86	4.87	122	4.97	4.96
88	4.86	4.85	123	4.97	4.99
89	4.82	4.91	124	4.94	4.99
90	4.88	4.95	125	4.91	4.99
91	4.95	4.99	126	4.88	4.98
92	4.94	4.89	127	4.84	4.97
93	4.91	5.02	128	4.82	4.89
94	4.98	5.12	129	4.85	4.87
95	4.98	5.06	130	4.88	4.86
96	4.98	5.13	131	4.98	4.87

Distance	North Track Elevation	South Track Elevation	Distance	North Track Elevation	South Track Elevation
132	5.02	4.81	167	4.62	4.74
133	5.05	4.80	168	4.59	4.62
134	4.99	4.76	169	4.58	4.56
135	4.95	4.75	170	4.53	4.47
136	4.90	4.73	171	4.46	4.50
137	4.90	4.76	172	4.42	4.64
138	4.97	4.74	173	4.41	4.53
139	5.00	4.74	174	4.40	4.50
140	4.93	4.74	175	4.39	4.47
141	4.87	4.71	176	4.39	4.54
142	4.76	4.66	177	4.49	4.51
143	4.69	4.68	178	4.49	4.45
144	4.62	4.64	179	4.34	4.36
145	4.65	4.65	180	4.47	4.35
146	4.66	4.65	181	4.33	4.33
147	4.67	4.66	182	4.16	4.28
148	4.76	4.69	183	4.29	4.27
149	4.78	4.64	184	4.25	4.23
150	4.81	4.59	185	4.21	4.18
151	4.86	4.68	186	4.19	4.15
152	4.87	4.71	187	4.21	4.30
153	4.88	4.74	188	4.21	4.31
154	4.88	4.78	189	4.24	4.15
155	4.89	4.81	190	4.25	4.06
156	4.95	4.76	191	4.22	4.10
157	4.93	4.76	192	4.21	4.10
158	4.91	4.77	193	4.20	4.11
159	4.91	4.72	194	4.19	4.11
160	4.90	4.87	195	4.18	4.11
161	4.94	4.96	196	4.17	4.11
162	4.94	5.04	197	4.16	4.11
163	4.86	5.07	198	4.15	4.10
164	4.77	5.03	199	4.13	4.10
165	4.67	4.97	200	4.12	4.10
166	4.65	4.90	201	4.13	3.98

Distance	North Track Elevation	South Track Elevation	Distance	North Track Elevation	South Track Elevation
202	4.05	3.95	237	4.10	4.29
203	3.97	3.92	238	4.05	4.33
204	4.10	3.96	239	3.80	4.29
205	4.11	3.99	240	3.84	4.26
206	4.13	4.02	241	3.85	4.16
207	4.14	4.05	242	3.87	4.04
208	4.16	4.08	243	3.94	4.00
209	4.17	4.11	244	4.00	4.07
210	4.16	4.11	245	4.07	4.19
211	4.15	4.12	246	4.13	4.17
212	4.14	4.12	247	4.17	4.18
213	4.09	4.12	248	4.28	4.11
214	4.03	4.12	249	4.24	4.02
215	3.97	4.10	250	4.15	3.95
216	3.92	4.09	251	3.99	3.64
217	3.91	4.00	252	3.80	3.40
218	3.91	3.91	253	3.57	3.29
219	3.93	3.93	254	3.55	3.30
220	3.95	3.96	255	3.61	3.35
221	4.02	3.98	256	3.69	3.41
222	4.09	3.99	257	3.68	3.45
223	4.08	3.04	258	3.78	3.50
224	4.08	3.08	259	3.78	3.51
225	3.97	4.07	260	3.78	3.52
226	3.99	3.97	261	3.77	3.54
227	3.96	3.96	262	3.74	3.58
228	3.93	3.94	263	3.71	3.64
229	3.94	3.89	264	3.61	3.60
230	3.92	4.00	265	3.59	3.43
231	3.94	4.20	266	3.54	3.34
232	4.01	4.34	267	3.51	3.20
233	4.05	4.33	268	3.44	3.23
234	4.10	4.35	269	3.38	3.21
235	4.19	4.27	270	3.32	3.21
236	4.16	4.25	271	3.20	3.15

Distance	North Track Elevation	South Track Elevation	Distance	North Track Elevation	South Track Elevation
272	3.18	3.08	307	2.24	2.00
273	3.20	3.04	308	2.11	1.92
274	3.24	3.04	309	2.32	1.87
275	3.19	3.02	310	2.24	1.81
276	3.11	2.94	311	2.14	1.83
277	3.08	2.85	312	2.05	1.78
278	2.98	2.86	313	1.90	1.78
279	2.90	2.86	314	1.75	1.85
280	2.98	2.89	315	1.62	2.07
281	2.87	2.81	316	1.69	2.08
282	2.86	2.85	317	1.73	1.95
283	2.84	2.89	318	1.73	1.88
284	2.83	2.73	319	1.73	1.91
285	2.76	2.70	320	1.74	1.85
286	2.69	2.67	321	1.78	1.80
287	2.66	2.67	322	1.83	1.90
288	2.63	2.68	323	1.88	1.82
289	2.70	2.58	324	1.91	1.62
290	2.73	2.55	325	1.91	1.56
291	2.75	2.59	326	1.84	1.64
292	2.84	2.58	327	1.73	1.56
293	2.86	2.53	328	1.63	1.46
294	2.84	2.46	329	1.52	1.50
295	2.82	2.56	330	1.44	1.44
296	2.86	2.59	331	1.46	1.47
297	2.80	2.53	332	1.48	1.51
298	2.71	2.40	333	1.46	1.40
299	2.59	2.37	334	1.52	1.33
300	2.52	2.28	335	1.67	1.27
301	2.40	2.25	336	1.51	1.22
302	2.37	2.18	337	1.44	1.23
303	2.34	2.15	338	1.35	1.11
304	2.30	2.13	339	1.26	1.14
305	2.31	2.14	340	1.19	1.07
306	2.32	2.09	341	1.11	1.18

Distance	North Track Elevation	South Track Elevation	Distance	North Track Elevation	South Track Elevation
342	1.03	1.19	377	.45	.51
343	.96	1.12	378	.44	.48
344	1.16	1.05	379	.40	.38
345	1.25	1.10	380	.38	.54
346	1.26	1.09	381	.35	.54
347	1.15	1.01	382	.39	.51
348	1.05	1.01	383	.43	.48
349	1.00	1.08	384	.44	.50
350	1.06	1.08	385	.46	.53
351	1.03	1.04	386	.48	.55
352	1.01	.99	387	.50	.58
353	.96	.93	388	.46	.55
354	.90	.88	389	.42	.52
355	1.04	.81	390	.46	.39
356	1.05	.72	391	.47	.43
357	.93	.67	392	.49	.47
358	.91	.60	393	.51	.52
359	.89	.57	394	.51	.51
360	.88	.55	395	.51	.50
361	.90	.58	396	.51	.50
362	.86	.60	397	.51	.49
363	.76	.56	398	.51	.48
364	.77	.58	399	.54	.51
365	.59	.53	400	.58	.55
366	.58	.54	401	.60	.55
367	.56	.55	402	.63	.56
368	.54	.56	403	.77	.60
369	.53	.51	404	.72	.63
370	.52	.66	405	.68	.65
371	.50	.63	406	.54	.64
372	.48	.61	407	.61	.69
373	.46	.59	408	.60	.70
374	.47	.57	409	.60	.71
375	.48	.56	410	.59	.72
376	.47	.54	411	.56	.72

Distance	North Track Elevation	South Track Elevation
412	.53	.72
413	.50	.71
414	.48	.71
415	.48	.71
416	.49	.70
417	.49	.70
418	.49	.70
419	.51	.77
420	.50	.76
421	.50	.76
422	.49	.75
423	.47	.66
424	.43	.65
425	.32	.63
426	.33	.61
427	.33	.58
428	.34	.55
429	.35	.53
430	.36	.55
431	.36	.55
432	.36	.55
433	.30	.53
434	.23	.51
435	.22	.50
436	.21	.49
437	.22	.47
438	.23	.45
439	.24	.42
440	.30	.40
441	.37	.38
442	.37	.38
443	.36	.38
444	.36	.38
445	.36	.38
446	.35	.38
447	.35	.38
448	.35	.38
449	.32	.39
450	.28	.40
451	.24	.41
452	.20	.42
453	.22	.54
454	.22	.56
455	.22	.58
456	.17	.44
457	.16	.53
458	.17	.55
459	.18	.58
460	.17	.57
461	.16	.55
462	.15	.53
463	.14	.51
464	.13	.49
465	.12	.53
466	.10	.56
467	.10	.51
468	.10	.46
469	.11	.43
470	.13	.39
471	.15	.35
472	.17	.32
473	.18	.28
474	.19	.29
475	.20	.30
476	.20	.30
477	.21	.31
478	.22	.32
479	.22	.33
480	.22	.33
481	.23	.34

Distance	North Track Elevation	South Track Elevation	Distance	North Track Elevation	South Track Elevation
482	.23	.34	517	.60	.64
483	.23	.35	518	.50	.43
484	.24	.37	519	.47	.24
485	.26	.40	520	.47	.21
486	.27	.43	521	.46	.29
487	.28	.45	522	.42	.33
488	.30	.47	523	.38	.36
489	.32	.48	524	.32	.43
490	.33	.49	525	.27	.39
491	.35	.50	526	.27	.29
492	.36	.49	527	.33	.32
493	.37	.48	528	.47	.48
494	.38	.48	529	.42	.53
495	.39	.47	530	.58	.63
496	.33	.58	531	.63	.50
497	.33	.66	532	.55	.41
498	.30	.59	533	.61	.35
499	.42	.60	534	.62	.31
500	.59	.48	535	.53	.38
501	.72	.56	536	.43	.29
502	.86	.58	537	.46	.41
503	.82	.47	538	.35	.43
504	.77	.49	539	.35	.30
505	.52	.53	540	.35	.24
506	.39	.65	541	.34	.35
507	.41	.50	542	.32	.52
508	.47	.48	543	.37	.35
509	.56	.53	544	.21	.34
510	.64	.58	545	.17	.24
511	.59	.62	546	.12	.05
512	.55	.62	547	.09	.09
513	.68	.72	548	.15	.14
514	.78	.77	549	.20	.17
515	.80	.80	550	.14	.26
516	.73	.77	551	.08	.26

Distance	North Track Elevation	South Track Elevation
552	.09	.27
553	.10	.27
554	.17	.28
555	.27	.26
556	.38	.28
557	.31	.22
558	.17	.22
559	.06	.15
560	.00	.07
561	.00	.08
562	.06	.12
563	.00	.15
564	.12	.13
565	.00	.12
566	.00	.20
567	.04	.32
568	.20	.47
569	.31	.45
570	.35	.60
571	.35	.60
572	.30	.58
573	.35	.41
574	.32	.56
575	.33	.68
576	.32	.65
577	.28	.56
578	.28	.49
579	.38	.49
580	.45	.50
581	.45	.55
582	.45	.60
583	.40	.55
584	.35	.51
585	.31	.54
586	.28	.58
587	.25	.60
588	.22	.61
589	.22	.63
590	.22	.64
591	.22	.65
592	.22	.66
593	.22	.68
594	.24	.78
595	.25	.82
596	.29	.77
597	.30	.71
598	.31	.65
599	.31	.65
600	.31	.65